CONCRETE PAVEMENT
CPTP
TECHNOLOGY PROGRAM

Concrete Pavement Technology Update

www.fhwa.dot.gov/pavement/conhome.htm

MIT Scan-2 trials at a South Carolina DOT installation.

About the Concrete Pavement Technology Program

CPTP is an integrated, national effort to improve the long-term performance and cost-effectiveness of concrete pavements by implementing improved methods of design, construction, and rehabilitation and the use of new technology. Mandated by Congress, this Federal Highway Administration program aims to foster innovation for the construction of safer, smoother, quieter, and longer lasting pavements. More than 30 CPTP projects are evaluating concrete pavement design features, materials, and best construction practices. Visit www.fhwa.dot.gov/pavement/conhome.htm for more information.

About CPTP Concrete Pavement Technology Updates

The CPTP Update is one facet of CPTP's technology transfer and implementation effort. Updates present new products and research findings that emerge from CPTP studies. To place your name on the mailing list, call (202-347-6944), fax (202-347-6938), or e-mail (dblumenthal@woodwardcom.com).

In This Update

U.S.Department of Transportation
Federal Highway Administration

Streamlining Dowel Bar Inspection

MIT Scan-2—a new magnetic tomography device based on principles of pulse induction—may improve evaluation of dowel bar placement in concrete pavements. The device rides on tracks as it is pulled across fresh or hardened concrete (photo, left) and determines the position and orientation (vertical and horizontal alignment) of all dowels in a joint in a single pass. Preliminary results are displayed almost immediately, and the scanner's automated data analysis produces visual and printed reports. Developed in Germany, the scanner's algorithms and user interface have been adapted for U.S. conditions.

Recently evaluated in a Concrete Pavement Technology Program (CPTP) project (Task 7F), MIT Scan-2 was found to be reliable, efficient, and accurate to within +/- 2 mm (0.08 in) when position errors are minimal. Accuracy depends on the degree of placement error. Within typical placement tolerances—.095 cm (0.38 in) for vertical and horizontal misalignment and 5.08 cm (2 in) for side shift—the range of error is +/- 4 mm (0.16 in). With gross misplacements, the error can be greater. The project tested the device in new concrete pavement construction and in retrofitted dowel bar installations. In new construction, testing showed that accurate scans can be obtained for both basket and insertion methods, but the dowel bars must be insulated (epoxy-coated or painted) and transport ties cut when evaluating basket installations.

State Field Trials

The California, Nevada, South Carolina, and Washington departments of transportation (DOTs) participated in CPTP field trials that evaluated the performance of MIT Scan-2. At each agency, the staff was favorably impressed with its capabilities and practicality.

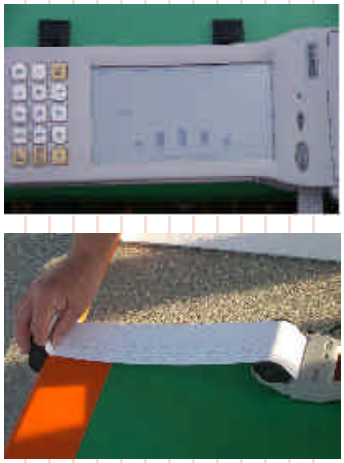
Trials in South Carolina, the first State to use MIT Scan-2 for quality control on a concrete paving project, found that testing a sample of 10 to 20 joints from each day's production was adequate to monitor performance; testing every joint can slow production.

Washington DOT checked 50 joints on a section of I-5 that had been retrofitted with dowel bars in 1996. Jim Weston reported that engineers found the scanner quick and easy to use—after setup, the 50 joints were checked in just 1 hour. He pointed out, however, that minimal training would be needed to interpret the positional data.

Tests were conducted at two sites in Nevada. Sohila Bemanian, Nevada DOT, commented that the trials were promising. "While not a panacea," she said, "overall this is a very powerful tool. It allows you to inspect 100 percent of your work on the first day of production,

continued page 2

Dowel Bar Alignment, continued from page 1



Immediate results on the display screen (above top) and analysis printouts for documentation (above bottom).

"Magnetic tomography, as demonstrated through FHWA's evaluation of the MIT Scan-2 device, has the potential to support the development and application of realistic dowel alignment criteria and, as a consequence, longer life pavements.

"This may well be a technology that can be used at the start of a paving operation to identify and correct typical problems with dowel alignment that other-wise would lead to dysfunctional joints and early distress."

Sam Tyson, Office of Pavement Technology, Federal Highway Administration

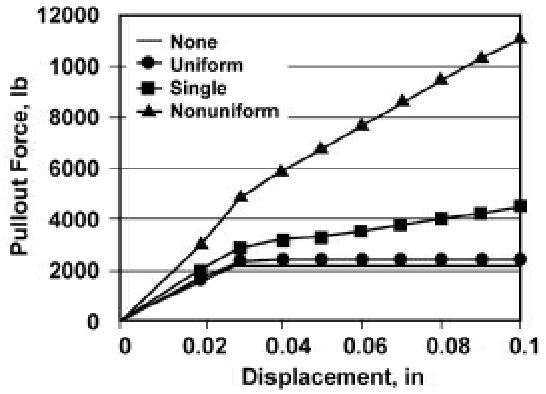
correct the installation procedure, and minimize misalignments in the finished pavement. The challenge now is to determine what specifications will ensure good pavement performance under various conditions in the field." Nevada DOT used the scanner to establish an acceptable rate of minor misalignments, and found that 3 to 5 percent was acceptable.

Investigators in California used MIT Scan-2 extensively in six new paving projects. Caltrans is developing draft test methods and will soon conduct independent tests, with a view to fully implementing the scanner in new paving and retrofits over the next 2 to 3 years if its accuracy and reliability are confirmed.

According to Tom Pyle, Caltrans, the volume of data produced by the scanner (nine points for each dowel bar) can make interpretation difficult. Currently, a specially trained crew performs the scan and prepares a report for the inspector at the job site. In addition, Caltrans engineers have developed spreadsheet applications to process the field data. Pyle expects the data collected by MIT Scan-2 to be immensely useful down the road in understanding the relationships between specific dowel misalignments and the timing and types of pavement deterioration.

MIT Scan-2 Versus GPR

The CPTP study compared the performance of MIT Scan-2 and ground-penetrating radar (GPR) and found that both technologies can produce accurate results and both have limitations. With GPR, variations in material properties, which can be substantial along a project, can create random errors that significantly affect analysis results. Water on the pavement surface or in the pavement structure can also drastically affect results. Although MIT Scan-2 is not affected by these factors, its operators must choose a scanning location carefully since magnetic fields and metal objects close to the joint being scanned—such as power lines, tie bars over the dowel, vehicles, marker nails in the concrete for sawcutting, even steel-toed boots—can throw off the scanner's results.



Effects of dowel bar misalignment.

Effects of Misalignment

An important finding of the CPTP study was that relative misalignment of bars is much more problematic in joint lockups than uniform misalignment (where all out-of-alignment bars are parallel), as shown in the chart at bottom left. The study also found that occasional locked joints might not cause problems when neighboring joints are working. In a dowel bar retrofit project in Washington, severe vertical misalignments of 2.5–5 cm (1–2 in) were found in many dowel bars. However, from a visual standpoint, the pavement is performing well.

Alignment Specifications

Existing specifications for dowel bar placement are largely untested because there has been no practical means of measuring alignment in hardened concrete until now. The CPTP study calls for further investigation to improve and validate specifications by identifying conditions that cause joint locking, determining the allowable number of locked joints, and ultimately developing specifications that are consistent with performance in the field. Although there is no ongoing work in developing dowel bar placement tolerances, MIT Scan-2 is being used to determine typical dowel bar alignments in in-service pavements in a project sponsored by the American Concrete Pavement Association.

In summary, expectations are high that the MIT Scan-2 will prove useful not only as an effective quality control tool for highway engineers but also as a research tool to investigate how the geometrics of dowel bar misalignments impact concrete pavement performance over time.

For More Information

ERES Consultants performed the CPTP project; the principal investigator was Tom Yu. For further details, contact Sam Tyson, FHWA Office of Pavement Technology: sam.tyson@fhwa.dot.gov.

Weighing Benefit-Cost Tradeoffs in Pavement Design

Until recently, there has been no means to evaluate the tradeoffs between performance benefits of design enhancements in portland cement concrete (PCC) pavements and the costs of these added features. Consequently, a Concrete Pavement Technology Program (CPTP) project (Task 6) set out to establish the performance benefits and construction costs of design features and to develop a simple method to evaluate the relative tradeoffs. The project produced new software that can help design engineers evaluate alternative concrete pavement designs.

The CPTP Study

The researchers reviewed the literature and identified 10 design feature categories for evaluation in the study: subgrade, base/subbase, drainage, thickness/slab size, shoulders, pavement cross-section, joints/load transfer, joint sealing, concrete strength/materials, and initial smoothness. They then surveyed State highway agencies and paving contractors to obtain information on relative performance benefits and costs associated with these categories. The highway agency survey suggested that slab thickness, base type, drainage, and dowels have a major effect on pavement performance; the contractor survey indicated that drainage, concrete shoulders, and high-early strength concrete mixes result in substantial pavement cost increases.

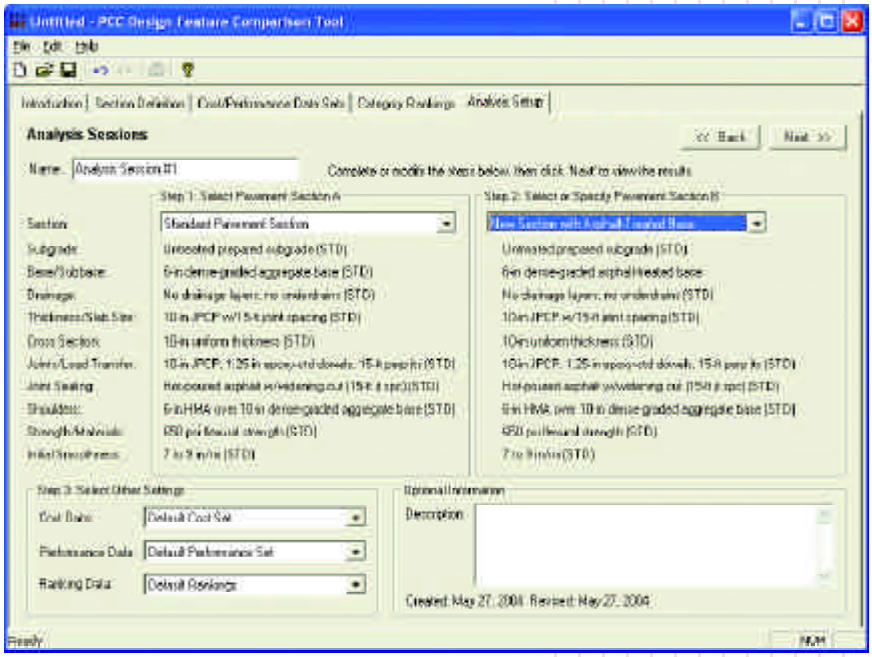
A simple, analytical approach was developed to assess tradeoffs between costs and performance. The approach was programmed into an analytical software program—PCC Design Feature Comparison Tool—to facilitate the analysis of different design scenarios.

Design Feature Comparison Tool

The PCC Design Feature Comparison Tool is not a design tool; it simply provides broad estimates of cost and performance for various design features, and it should therefore be used with caution. Agencies using the Comparison Tool are encouraged to develop their own data sets to reflect local conditions and costs. As Peter Kopac, Office of Infrastructure Research and Development, Federal Highway Administration, advised: "Although default values are provided, the user should input his or her own estimates of relative costs and performance. Preferably, the inputs should be based on available performance models or information from databases. If the input estimates are not close, the answer will not be either."

"The PCC Design Feature Comparison software is a good educational tool for people who want to better understand concrete pavement design and its impact on construction costs and performance."

Peter Kopac, Office of Infrastructure Research and Development, Federal Highway Administration



The Analysis Setup dialog box for a Direct Comparison.

The software provides two types of analysis: Direct Comparison, which compares two defined pavement sections with different design features to assess expected differences in cost and performance (see screen, above); and Sensitivity Analysis, which permits more complex, sensitivity-type analyses such as comparing one pavement section to multiple sections or assessing the sensitivity of a chosen design to changes in other inputs.

For More Information

Applied Pavement Technology performed the study; the principal investigator was Kurt Smith. For more information or to obtain the comparison software, contact Peter Kopac: peter.kopac@fhwa.dot.gov.

See www.tfhrc.gov/pavement/pccp/pubs/04045 for the project TechBrief: Incremental Cost and Performance Benefits of Concrete Pavement Design Features.

CPTP Long-Term Plan for R&D

Major Technology Tracks for Future Research

- Advanced Equipment
- Advanced Materials
- Business Systems
- Concrete Pavement Accelerated and Long-Term Data Collection
- High-Speed Nondestructive Testing and Intelligent Construction Systems
- High-Speed Rehabilitation and Construction
- Innovative Joint Design, Materials, and Construction
- Long-Life Concrete Pavements
- Pavement Performance
- Performance-based Design Guide for New and Rehabilitated Concrete Pavements
- Performance-based Mix Design System
- Surface Characteristics

One of the most significant products of the Concrete Pavement Technology Program (CPTP) is the "Concrete Pavement Long-Range Research and Technology Plan—A Strategic Road Map." The Road Map is intended to guide portland cement concrete pavement research, development, and technology activities over the next 10 years in a rational and nationally coordinated way.

In 2003, the first phase of the project gathered extensive input from stakeholder representatives in Federal, State, and local agencies; contractors, suppliers, and consultants; professional associations; and academics, particularly those conducting applied research. The stakeholders identified desirable characteristics of future concrete pavements and helped define future research and technology needs. At a final outreach session in October 2004, senior stakeholder representatives will review the final draft Plan, comment, and kick off formal implementation.

"This Road Map, along with the creative Implementation Plan, presents a clear picture of the concrete pavement industry's future," says Dale Harrington, contract administrator. "The Strategic Road Map identifies nearly 200 projects under 12 major research tracks and describes how agencies all across America can participate."

For More Information

Details of the Plan are available at www.pccpavement.com. Iowa State University is administering the project; the team also includes TDC Partners, Ltd, The Transtec Group, and ARA–ERES Division, with Ted Ferragut as principal investigator. For more information, contact Ted (tferragut@tdcpartners.com) or Federal Highway Administration representatives Peter Kopac (peter.kopac@fhwa.dot.gov) and Tom Harman (tom.harman@fhwa.dot.gov).

CPTP Focus Areas and Projects

More than 30 CPTP projects are underway in six focus areas: design, materials, construction, repair and rehabilitation, workforce training, and user satisfaction.

Advanced Pavement Design

- Contributions to *M-E Pavement Design/ 2002 Pavement Design Guide* (ISLAB 2000 and coefficient of thermal expansion test)
- Cost-effective design features
- High-performance pavements
- Improved joint systems
- Ultrathin whitetopping design process

Improved Concrete Materials

- Compatible combinations of concrete materials
- Concrete mixture optimization
- Improved concrete characteristics

Improved Construction Processes

- Concrete curing
- Construction traffic management
- Dowel bar placement control
- Impact of smoothness specification
- Improved construction management—HIPERPAVE II & TEMP
- Mobile concrete laboratory
- Performance-related specifications

Rapid Repair and Rehabilitation

- Field trials of promising methods
- Improved rehabilitation guidelines and strategies
- Nondestructive testing
- Precast panels for full-depth repair
- Precast panels for rapid rehabilitation
- Repair of ultrathin whitetopping
- Weekend intersection reconstruction

Enhanced User Satisfaction

- Congestion reduction
- Optimal surface texturing for noise and accident reduction
- Smoothness criteria
- Smoothness data analysis

Workforce Training

- Communications (web site, newsletter, product alerts)
- Field demonstration projects
- Guides and training materials
- Other technology transfer activities
- Workshops for State transportation departments and academia

Assessing Concrete Strength With TEMP

Maturity methods of testing are being used by more and more agencies to monitor temperatures in newly placed pavements to determine appropriate times to open the pavement to traffic. Recently, the Total Environmental Management for Paving (TEMP) system, a maturity data acquisition system that enhances maturity monitoring technology, was demonstrated in Concrete Pavement Technology Program (CPTP) Task 7E. The TEMP software combines temperature, maturity, and strength predictions into a single measurement system that can be accessed onsite or remotely with a handheld or laptop computer. It gives accurate and instantaneous feedback on temperature and concrete strength development.

TEMP's basic components are concrete temperature sensors and a computing device loaded with the TEMP software (see illustration, right). A variety of temperature sensors can be used, including the iButton, a commercially available, self-powered, and self-contained device that can record temperature measurements at user-defined intervals between 1 and 255 minutes. The temperature sensors can be interfaced with a computer via a direct (serial) connection or a wireless radio transceiver. The illustration also shows an optional portable weather station that can be added to further enhance the software's predictive ability.

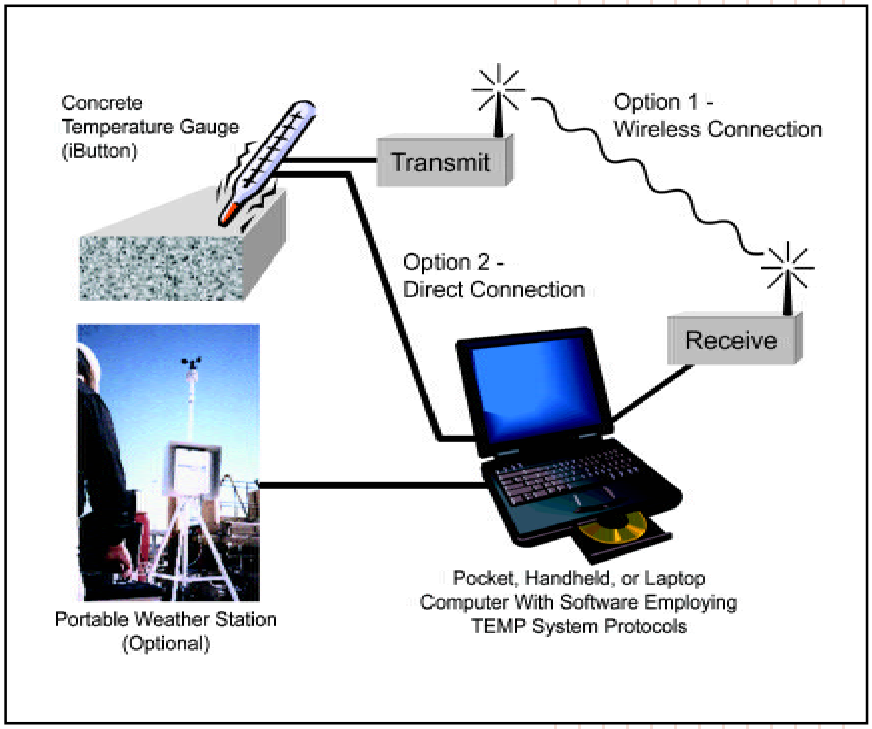
The primary use of the TEMP system is to identify the appropriate time for joint sawing or opening a concrete pavement facility to traffic, based on achieving a specified strength. Prediction of opening times is based on the past (known) and future (predicted) concrete temperatures, using models from the HIPERPAV program. The system eliminates the need to reference a chart or look-up table to convert the maturity value to a strength value. The minimum strength criterion to open to traffic is used to convert from strength to time, and this predicted time to open to traffic can be interpreted from the software.

The CPTP TEMP project implemented and evaluated the system in three concrete paving projects: 320th Street, Washington County, and US 151, Jones County, Iowa (both new construction); and I-64, Williamsburg, Virginia (pavement patching). In these installations, TEMP was used to produce real-time maturity-based estimates of strength and to predict future (maturity-based) strength. Differences between maturity-estimated strength and predicted strength were monitored and found to be no more than 5 percent. In some cases, TEMP system estimates were within 1 percent of the strength estimated from the maturity sensors.

Overall, the study further confirmed that maturity methods and the TEMP system can be used to assess the strength of concrete pavement in real time.

Benefits of the TEMP System

- Improved accuracy of strength estimations
- Expedited repair and construction activities
- Reduced labor costs and errors associated with data management and analysis
- Improved knowledge of the early-age properties of in-place concrete pavement



The TEMP system.

For More Information

The Transtec Group conducted the demonstrations; the principal investigator was Robert Rasmussen. For details and the final project report, contact Sam Tyson, Office of Pavement Technology, Federal Highway Administration: sam.tyson@fhwa.dot.gov.

CPTP Begins Implementation Effort

The Concrete Pavement Technology Program (CPTP) recently initiated a project (Task 65) to bring the program's products to market. The project team will produce information and tools to promote implementation of tested technologies.

The Implementation Team will provide product-specific marketing, deployment, and delivery activities as well as engineering support to agencies and contractors.

CPTP is an important undertaking of the Federal Highway Administration (FHWA) in partnership with State departments of transportation (DOTs), industry, and academia. The program is producing innovations and findings that pavement engineers and managers can apply to design and construct more cost-effective and longer lasting pavements and to improve the quality and speed of rehabilitation. Task 65 provides a framework for monitoring and implementing these innovative products and for maintaining a coordinated followup of implementation.

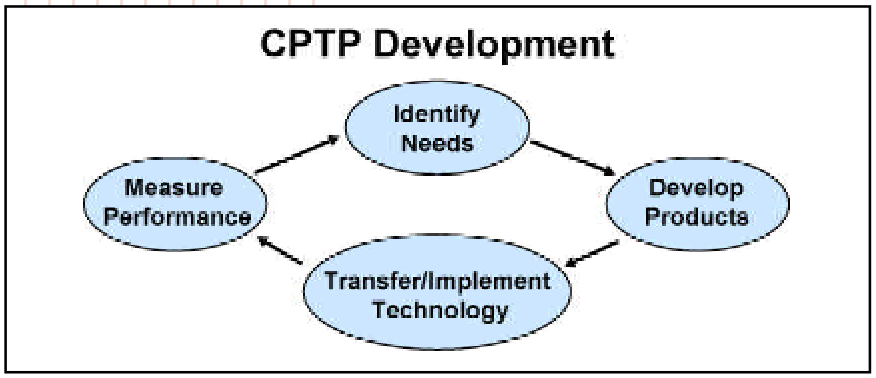
Mission and Objectives

The Implementation Team will champion promising innovative concrete pavement research products and technologies through partnering, training, effective communications, and marketing. To achieve that mission, five goals have been identified:

- Develop implementation strategies for promising CPTP products.
- Identify and enlist partners and champions for implementation.
- Identify and overcome barriers to implementation.
- Market the products.
- Follow up implementation to identify any improvements needed for the products.

CPTP Marketing and Implementation Products

- Detailed Status Report of CPTP projects and products (available now)
- Refined and implementable CPTP products (under development)
- Marketing Plan for CPTP products (future development)



Marketing and Implementation Activities

Four specific tasks are to be performed in support of the implementation project's mission and objectives:

1. Prepare a Detailed CPTP Status Report—summarize CPTP and related research and development activities. The report will be informed by the work of expert task groups that represent major stakeholders (State DOTs, industry, research organizations, academia, and FHWA). The draft Status Report, posted at www.fhwa.dot.gov/pavement/conhome.htm, will be updated periodically.

2. Prepare a CPTP Marketing Plan—recommend to FHWA the technology transfer, deployment, and delivery activities that are needed to achieve CPTP goals and identify successful pavement product marketing strategies.

3. Refine and Package CPTP Products—evaluate products and findings from CPTP projects, select and refine products for deployment, and package the refined products for deployment.

4. Implement the Approved Marketing Plan—provide the engineering and marketing support services that are needed for timely and cost-effective technology transfer. Make an early assessment of the Plan's implementation.

To maintain momentum, the marketing effort will be ongoing. It will build on successes by publicizing innovative products, training materials, and successful implementation activities.

For More Information

The implementation project contractor is Construction Technology Laboratories; the principal investigator is Shiraz Tayabji. The contract team includes Applied Pavement Technology, Soils and Materials Engineers, and Woodward Communications.

Additional information is available from Sam Tyson, FHWA Office of Pavement Technology: sam.tyson@fhwa.dot.gov.

CPTP Executive and Engineering Expert Task Groups Guide Implementation Effort

Most Concrete Pavement Technology Program (CPTP) projects include provisions for establishment of expert task groups (ETGs) to provide technical advice and guidance to the project contractor teams in the conduct of the project. The ETGs typically meet at project milestones to review project status and products developed under each phase of the project. ETG membership includes experts in the subject matter from State departments of transportation (DOTs), the Federal Highway Administration (FHWA), industry, and academia.

For the CPTP Implementation effort (Task 65, see page 6), two ETGs have been organized. The 19-member Executive ETG consists of senior management from State DOTs, FHWA, industry, and academia. The Executive ETG will provide broad guidance and recommendations concerning the needs of transportation agencies and industry, institutional issues and barriers, and product implementation strategies, and make other contributions to CPTP success. The Engineering ETG, consisting of technical experts from State DOTs, FHWA, industry, and academia, will focus on specific agency, industry, and academia needs and recommend how specific CPTP products can be deployed to meet these needs. The Engineering ETG will also assess the suitability of promising CPTP products and ascertain whether they need additional development.

Engineering ETG Reviews CPTP Projects

The 29-member engineering ETG, appointed in December 2003, represents a broad spectrum of CPTP stakeholders. The group will advise the Implementation Team regarding CPTP technology transfer, marketing, and communications activities.

Fifteen ETG members attended the first meeting in February 2004 in Denver, Colorado, with Implementation staff and Sam Tyson, FHWA contracting officer technical representative. Much of the agenda was devoted to bringing the members up to speed on projects. The staff and Tyson described the more than 30 CPTP projects, organized in six focus areas (see page 4), and a lively discussion of the projects followed.

The ETG next discussed proposed project implementation activities including newsletters, workshops, and product briefs. Several members expressed keen interest in how communications and implementation efforts might proceed, and voiced their concerns and ideas, as in these examples:

- Linda Pierce of the Washington DOT urged strongly that avenues in addition to workshops be used to disseminate information, citing Web-based programs and interactive CDs as examples. Pierce later distributed a "pavement guide interactive" from her department as an example.
- Jerry Voigt of the American Concrete Pavement Association encouraged the group or CPTP staff to identify and prioritize "early wins"—projects that are ready for implementation. He noted thin white-topping software, high-performance concrete, and traffic management strategies for construction zones as possibilities.
- Moon Won, Texas DOT, urged the group to make sure that products promoted make sense to engineers and pointed out that the products must be saleable and without conflicting information.
- John Wojakowski, Kansas DOT, noted that program "flaws" must be avoided, as "it will take only one failure to destroy credibility." He agreed that conflicting findings must never be delivered.

Executive ETG Meets

The Executive ETG is chaired by Joseph Deneault, vice president, HNTB, and former chief engineer, West Virginia DOT. Highlights of the group's first meeting, held August 26 in Washington, DC, will appear in the next CPTP Update.

Executive ETG Members

Joseph Deneault, HNTB, Chair

State Departments of Transportation

J. Mike Leonardo, California
Freddie Simmons, Florida
Paul Mullins, Georgia
Kevin Mahoney, Iowa
Paul T. Wells, New York
Gary Hoffman, Pennsylvania
Malcolm Kerley, Virginia
Don Nelson, Washington

Industry

Mike Byers, ACPA Chapter Executives
Leet Denton, Denton Enterprises, Inc.
Terry Holland, Silica Fume Association
Ken Rear, Lehigh Cement
Mike Shydlowski, Master Builders/Degussa
Rick Sniegowski, K-Five Construction Corporation

Academia

Ernie Barenberg, University of Illinois

American Association of State Highway and Transportation Officials

Ken Kobetsky

Federal Highway Administration

Tommy L. Beatty, Office of Pavement Technology
T. Paul Teng, Office of Infrastructure Research and Development

For information related to the ETGs, contact Shiraz Tayabji (stayabji@ctlgroup.com).

CPTP Training Opportunities

Many State highway agencies are beginning to specify long-life concrete pavements that are expected to provide low-maintenance, initial service lives of 40 to 50 years. Specifying such high-performing pavements requires the use of effective design features, optimal materials, and best construction practices. In each of these areas, the Concrete Pavement Technology Program (CPTP) is making a workshop available to State highway agencies. The three workshops incorporate innovative concrete pavement technologies and research findings that have emerged from CPTP projects.

- Best Practices for PCC Pavements: Long-Life PCCP Design and Construction Features
- Concrete Paving Materials and Optimizing Concrete Mix Design (under development)
- Concrete Pavement Construction Best Practices—Recent Advances (under development)

The first workshop in the series—Best Practices for PCC Pavements—was conducted at the request of the Alabama Department of Transportation in Montgomery in April 2004 by the CPTP Implementation Team and Federal Highway Administration (FHWA) staff. Thirty Alabama staff attended, representing the design, materials, construction, and district offices.

The workshop covered a range of topics: pavement design, concrete materials and mix designs, the construction process and construction management aids, alternate design and bid approaches, and maintenance, repair, and rehabilitation. Instructors included Celik Ozyildirim, Kurt Smith, Shiraz Tayabji, Sam Tyson, and others.

The CPTP Implementation Team is available to present the three workshops at dedicated State or regional venues or to present condensed versions of the workshops in conjunction with other State, regional, and industry meetings. To schedule a workshop or participation in a meeting, contact Sam Tyson, FHWA Office of Pavement Technology: sam.tyson@fhwa.dot.gov.

New Mechanistic-Empirical Pavement Design Guide Workshops

Several CPTP projects are contributing to the development and implementation of mechanistic pavement design procedures. A series of seven Design Guide implementation workshops is being conducted by FHWA for State DOTs around the country, with workshops now completed in Connecticut, Mississippi, Hawaii, Indiana, and Washington. Future workshop dates and locations are as follows:

September 14, 2004, Kansas City, KS
October 20, 2004, Phoenix, AZ
October 26, 2004, Fredericksburg, VA

For more information, contact Sam Tyson: sam.tyson@fhwa.dot.gov.

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